"SYNTHESIS, CHARACTERIZATION AND STUDY OF ANTIMICROBIAL ACTIVITIES OF THE SCHIFF BASES OF SOME OF THE NATURALLY OCCURRING AMINO ACIDS & TRANSITION METAL COMPLEXES"

A Synopsis

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By

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THE SYNOPSIS

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STATE OF THE ART

Schiff bases are named after Hugo Schiff, an Italian German Chemist who discovered them in 1864 [1] [2] . They are formed by the condensation reaction of either aliphatic or aromatic primary amines with aldehydes or ketones [3, 4] [5]. Schiff base ligands are easily synthesized [6]. They are excellent coordinating molecules and form stable complexes with many metal/metal ions [7]. These complexes exhibit a variety of biological actions, such as antifungal [8] [9], antimicrobial [10] [11] [12] [13] [14] [15], antiviral [16], antimalarial [17], antidiabetic [18], antioxidant [19] [20] [21], anti-inflammatory [22], and anticancer activities [23].

Schiff bases derived from chiral amino acids remain chiral and are used in asymmetric synthesis [24]. Schiff bases synthesized from 5-chlorosalicylaldehyde with amino acids in the presence of sodium hydroxide catalyst have received significant interest for their biological activities [25] [26] [27]. The stable complexes of transition metals (Cu, Zn, Ni, Co, Mn) and the Schiff bases from 5-chlorosalicylaldehyde with natural and synthetic amino acids also inhibit the bacterial and fungal growth [28] [29] [30]. These metal complexes showed enhanced bacterial activities compared to the uncomplexed ligands [31].

An antimicrobial is an agent that kills or inhibits the growth of microorganisms. Antimicrobial activity of the Schiff base synthesized from 5-chlorosalicylaldehyde with amino acids was tested against gram-positive and gram-negative organisms. The antibacterial properties of the ligand and metal complexes (Cu, Zn, Ni, Co, Mn) were evaluated using the disc diffusion method [32].

The characterization of Schiff base ligand and its metal derivatives was performed using elemental analysis, FTIR, ^{1}H-NMR, ^{13}C-NMR, and UV-visible spectroscopic methods.

PROBLEMS TO BE INVESTIGATED

The purpose of this study is to explore new and more effective Schiff's base-based metal complexes to be used as antimicrobial and antifungal agents. There is ample information available regarding the Schiff base metal complexes as antimicrobials, but the use of naturally occurring amino acids in these complexes has not been explored much. These studies led to the idea that Schiff bases of amino acids could have potential antimicrobial properties. The antimicrobial properties of the Schiff bases using naturally occurring amino acids will be investigated against a variety of bacterial species, including Escherichia coli, Staphylococcus aureus, and Bacillus subtilis.

OBJECTIVE OF THE INVESTIGATION AND MOTIVATION

- Study the stability and reactivity of the complex formed from the interaction of Schiff bases and metal complexes.
- Explore the catalytic activity of Schiff base metal complexes in a variety of chemical processes, including oxidation, reduction, and polymerization.
- Evaluate the potential of these complexes for biological, bio medicinal catalysis, and material science.
- Analysis of antimicrobial properties against various bacteria like E. coli, S. aureus, and B. subtilis.
- Developing effective and eco-friendly techniques for synthesizing Schiff bases from amino acids is essential for large-scale production and research.

HYPOTHESIS

Schiff base metal complexes have been the subject of intensive research due to their unique characteristics and their industrial and biological significance [33] [34]. The amino acid derivative also performs biological and catalytic activities in several synthetic reactions. These ligands and their transition metal complexes (Zn, Cu, Ni, Co, Mn) have various applications, including anti-inflammatory, antiviral, antibacterial, antifungal, and antioxidant properties [35].

In this study, new Schiff base ligands are synthesised from 5-chlorosalicylaldehyde, with certain amino acids (cysteine, serine, histidine, tyrosine, methionine), by the condensation reaction using the microwave irradiation method [36].

Microwave irradiation is a pollution-free, eco-friendly, and low-cost method for carrying out chemical transformations that provides excellent yields [37]. Microwave

heating, as an alternative energy source, allows for using eco-friendly solvents or solvent-free conditions and enhances catalytic reactions due to its rapid heating and energy transfer to the reaction media [38]. The microwave-assisted synthesis of various types of Schiff bases and their derivatives has been reported by Valavi A.R. and Sawant C.P. The most widely used and straightforward method for these reactions is now considered solvent-free microwave synthesis of Schiff bases, which has several applications [39]. The microwave synthesis of amino acid Schiff bases is extremely important in this field.

RESEARCH DESIGN AND METHODOLOGY

1. Synthesis of 5-chlorosalicylaldehyde with an amino acid (cysteine, methionine, tyrosine, serine, histidine) under solvent-free conditions in a microwave oven at 750W for 10 minutes.
2. Synthesized Schiff base ligand will be mixed with metal salt (MCl_2) and subjected to microwave irradiation for 10 minutes at 750 W.
3. After completion of the reaction, the product will be purified.
4. The antibacterial property of metal complexes will be tested against E. coli, S. aureus, and B. subtilis.
5. Antimicrobial activities will be evaluated using the disc diffusion method.
6. Characterization of Schiff base ligands and metal complexes will be done by using elemental analysis, FTIR, ^{1}H-NMR, ^{13}C-NMR, and UV-vis spectroscopy.

Data from other sources will be compared with the data generated in our findings.

TOOLS TO BE USED FOR THE COLLECTION OF DATA

A. Primary Source

The key to unlocking the mysteries of the world lies in the data we collect, and the primary source of this data is through experiments and observations. By extracting valuable insights from these observations, we gain a better understanding of the world around us. So let us continue to push the boundaries of scientific discovery by utilizing the power of experimentation and observation.

Magnetic stirrer with hot plates, Beakers, conical flask, watch glass, weighing balance, filter paper, dropper, pipette, test tube, funnels, petri dishes, microwave oven, Refrigerator, TLC, XRD, TEM, FTIR, ^{1}H-NMR, ^{13}C-NMR, UV-vis spectroscopy.

B. Secondary Source

Secondary sources for research can be found in journals, books, and online data available on the internet.

SIGNIFICANCE OF THE WORK

The strong biological properties of Schiff base ligands and transition metal complexes (Cu, Zn, Ni, Co, Mn) being recognized, new bioactive compounds with enhanced antibacterial and antifungal activity would have resulted from their combination [40]. Schiff base amino acid complexes have drawn a lot of attention because of their strong biological activity [41] [42]. These are a key family of organic compounds due to their capacity to form complexes with transition metal ions(Cu, Zn, Ni, Co, Mn) and their pharmacological effects [43] [44].

The literature reveals that Schiff base complexes have a very special role in the evolution of inorganic chemistry. It has been discovered that the Schiff bases and transition metal complexes (Cu, Zn, Ni, Co, Mn) function as strong pharmacologically active substances in biological systems [45] [46]. These transition metal complexes (Zn, Cu, Ni, Co, Mn) show a positive effect on the selected antibacterial strains. Complexes with Schiff bases are extensively discussed in the literature due to their multiple actions and several benefits, such as low cost and easy synthesis [47] [48]. In the present study, we synthesize and characterize Schiff bases using 5-chlorosalicylaldehyde with amino acid (cysteine, serine, histidine, tyrosine, methionine) and metal complexes (Cu, Zn, Ni, Co, Mn) [49].

RELEVANCE TO WORK

There are known skin diseases that have no treatment, and people have to live with them. There are medicines to suppress the adverse and annoying effects of skin diseases caused by microbes, but an effective cure has not been discovered till date. In today's world, human health has drawn attention worldwide and people are increasingly prioritizing fitness, beauty, and health, leading to an increased focus on a disease-free life. A new, positive perspective on effective medicines and health is emerging, emphasizing the benefits of "effective and potential antimicrobials".

FUTURE WORK

The Schiff base ligand is currently widely used in research due to its easy synthesis. Schiff base complexes continue to be an important and popular area of research. In recent years, there has been an increased interest in discovering and producing new antimicrobial agents derived from various sources to tackle microbial resistance [50]. The biological characteristics of these previously synthesized complexes still need to be investigated, and new complexes with additional qualities need to be created.

These compounds show a bright path towards biological activities; therefore, researchers are trying to learn more about the antibacterial action of Schiff base ligands [51].Nowadays, these complexes are effectively used in green chemistry. In this study, new amino acid derivatives will be synthesized using microwave, and the best reaction conditions to produce molecules with high yields and purity are determined [52].

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